



Android Common Kernel and Out of Tree Patchset

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LMG
Mobile

Session Layout

- Android common kernel
 - Rationale and Brief Introduction
 - Patchset evolution
- linux-v4.14.y vs android-4.14
 - Git diff stats - v4.14..android-4.14
 - Quick intro of out of tree patches/functionality and upstream status
- experimental/android-mainline-tracking
 - Rationale and Brief introduction
 - Git diff stats - linux/master..experimental/android-mainline-tracking
- Android patchset delta and call to action

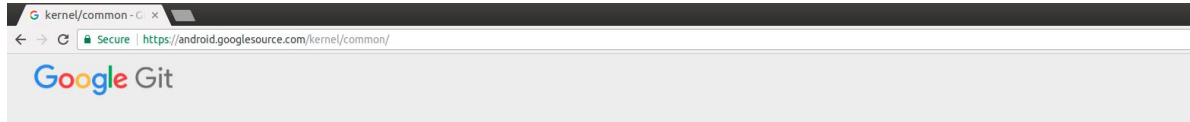
Android Common Kernel

Android Common Kernel Rationale



- Downstream Long Term Stable (LTS) kernel
- Plus a handful(400+) of out of upstream tree patches
 - Features tailored for Android needs e.g. quota2, qtaguid
 - Features rejected by upstream owing to implementation concerns e.g. USB gadgets, Paranoid networking
 - Testbed for features to be pushed upstream overtime e.g. EAS
 - Features which are available mainline but Android still using in-house implementations e.g. PPPoPNS, PPPoLAC
 - Vendor/OEM features which deemed useful for whole ecosystem e.g. sdcardfs
- Channel for partners to get timely updates including LTS patches, bugfixes and new Android features

Android Common Kernel Tree



[android](#) / [kernel](#) / **common**

Common Android Kernel Tree

Clone this repo:

```
git clone https://android.googlesource.com/kernel/common
```

Branches

[fe8bf45](#) [empty commit](#) by Jean-Baptiste Queru · 6 years ago [master](#)

[More »](#)

[master](#)

[android-3.10](#)

[android-3.10.y](#)

[android-3.18](#)

[android-3.18-n-release](#)

[android-3.18-o-mr1](#)

[android-3.18-o-release](#)

[android-4.14](#)

[android-4.4](#)

[android-4.4-eas-test](#)

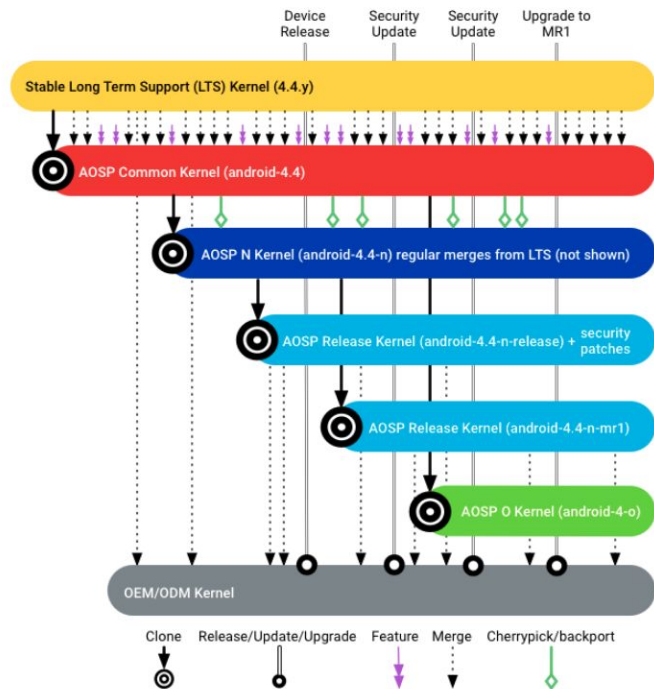
[More...](#)



Android Common Kernel Branch Hierarchy

Branch hierarchy (android-4.4)

The branch hierarchy for the android-4.4 kernel uses the following structure:



Android Common Kernel Testing

- Moved from a mere reference set of patchset dump to community driven build/boot tests and functional testing.
- KernelCI
 - KernelCI build loop and smoke test for android common kernels
<https://kernelci.org/job/android/>
- Linux Kernel Functional Testing
 - Running Android VTS/CTS and upstream Kselftests/LTP subset of tests
 - Test reports <https://qa-reports.linaro.org/lkft>
 - [ELC2018: Keeping up with LTS: Linux Kernel Functional Testing \(LKFT\) on Devices - Thomas Gall, Linaro](#)

Android Patchset Evolution

What's in the Android Patches?

- ~~Ashmem~~
- ~~Binder~~
- ~~Pmem~~
- ~~Logger~~
- ~~Early suspend~~
- ~~Wakelocks~~
- ~~Alarm Timer~~
- ~~LowMemoryKiller~~
- Paranoid network
- ~~Yaffs2 fs~~
- ~~Ram_console~~
- ~~Apanic~~
- ~~Adb gadget driver~~
- Gpio patches
- Lots of other small fixes and hacks for arm, mmc, Bluetooth™, etc.

v4.4..android-4.4 git diff stats

- 523 files changed, 46634 insertions(+), 1634 deletions(-)
 - Including UPSTREAM / BACKPORT / FROM LIST fixes
- ~14% Networking
- ~09% Energy Aware Scheduling
- ~09% USB Gadgets
- ~09% Atomic Display Framework
- ~08% Verity Boot
- ~08% Sdcard FS
- ~04% FIQ debugger
- ~04% Input
- ~03% Cpufreq
- Rest: Documentation, include, kernel, arch, mm..

[Android OS for servers? - John Stultz, ELC2011](#)

[LAS16 - The State of AOSP common android-4.4 Kernel](#)

linux-4.14.20 vs android-4.14

v4.14.20..android-4.14 git diff stats

- 432 files changed, 39445 insertions(+), 2730 deletions(-)
 - Including UPSTREAM / BACKPORT / FROM LIST fixes
- ~12% Sdcard FS
- ~11% Netfilter
- ~11% Energy Aware Scheduling
- ~06% USB gadgets
- ~05% Input
- ~05% Fiq debugger
- Others: arch/, Documentation/, include/ et al.

v4.4..android-4.4 git diff stats

- 523 files changed, 46634 insertions(+), 1634 deletions(-)
 - Including UPSTREAM / BACKPORT / FROM LIST fixes
- ~14% Networking (~~UID Based Routing, PPP, SIOCKILLADDR~~)
- ~09% Energy Aware Scheduling
- ~09% USB Gadgets (~~MTP/PTP, Misc RNDIS hacks/fixes~~)
- ~~• ~09% Atomic Display Framework~~
- ~08% Verity Boot
- ~08% Sdcard FS
- ~04% FIQ debugger
- ~04% Input
- ~~• ~03% Cpufreq (Interactive Governor)~~
- Rest: Documentation, include, kernel, arch, mm..



[LAS16 - The State of AOSP common android-4.4 Kernel](#)

v4.14.20..android-4.14 git diff stats

- 432 files changed, 39445 insertions(+), 2730 deletions(-)
 - Including UPSTREAM / BACKPORT / FROM LIST fixes
- ~12% Sdcard FS
- ~11% Netfilter
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- ~05% Input
- ~05% FiQ debugger
- Others: arch/, Documentation/, include/ et al.



v4.14.20..android-4.14 git diff stats

- ~31% drivers/
 - ~06% usb gadgets
 - ~05% fiq_debugger
 - ~03% goldfish
 - ~05% input
(keychord, keyreset/keycombo, gpio)
 - ~03% dm (dm-android-verity)
 - ~02% misc
(uid sys stats, memory state time)
- ~23% fs/
 - ~12% sdcardfs
 - ~05% f2fs upstream backports
 - ~03% squashfs
- ~12% net/
 - ~11% netfilter (quota2, qtaguid)
 - Paranoid networking, NFC fixes
- ~13% kernel/
 - ~11% Energy Aware Scheduling
 - Wakeup reason logging/reporting
- ~05% arch/
 - Appended -dtb kernel Image build targets
 - Debug hooks, Ranchu defconfigs etc
- Others:
 - Documentation, include, mm, mmc, tracing hooks et al.



File System

- SdcardFS

- What is sdcardfs?
 - FUSE alternative for emulated storage in AOSP
 - Got rid of a lot of I/O performance overhead in Fuse
 - Not a traditional file system like ext4, fat32
 - File system wrapper derived from wrapfs
 - Implement in-kernel FAT32 emulation layer to manipulate permissions and case sensitivity
 - Shipped in Samsung devices for long
- Upstream to staging tree is in progress
 - [LPC2017: SDCardFS Upstreaming - Daniel Rosenberg, Google](#)
 - Fuse support being completely dropped from AOSP broke Android testing/development efforts with mainline kernel
- Huawei's sdcardfs implementation (hwsdcardfs)
 - Huawei's in house sdcardfs alternative, up for review on [Android Gerrit](#)
 - Already shipping in Mate 10/Pro and other devices.



File System

- F2FS (Flash-Friendly File System)
 - Developed for NAND flash memory-based storage devices from the ground up
 - Follow upstream development model and patches backported on Android kernel
- SquashFS
 - Read-only compressed filesystem for Linux devices
 - Out of tree Android changes include:
 - Custom readpages() implementation
 - Pack as much pages as possible in the same page actor so that only 1 read request is issued.
 - Optimize reading uncompressed data
 - lz4 being recommended compression algorithm



Networking

- Paranoid networking
 - Restrict network access to certain group of users
 - Largely perceived as Android hacks with hardcoded AIDs mapped to userspace groupids
 - Hardcoded userIDs rejected upstream
 - Asked to move to n/w namespaces for n/w filtering based on control groups instead.
 - Require a fair bit of userland changes and unlikely to happen to save mere tens of lines of out of tree code.
 - On recent Android releases, access to services/daemons can be enabled via upstream CAP_NET_RAW and CAP_NET_ADMIN capabilities as well.
 - So we might be able to drop few paranoid networking checks in future.

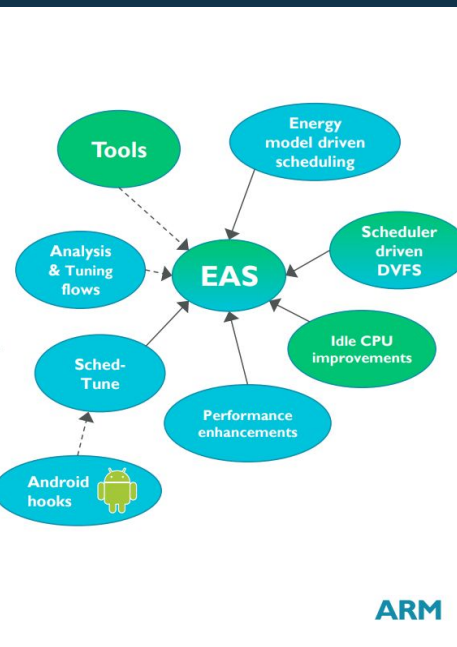


Networking

- Netfilter: qtaguid, quota2, idletimer
 - Data usage tracking & limiting
 - qtaguid and quota2 modules to do per uid usage tracking and accounting
 - [LPC2017: Replacing xt_qtaguid with an upstream eBPF implementation](#)
 - IDLETIMER notifications
 - Help ConnectivityService deal with quiet interfaces
 - Track and send netlink messages when interface becomes active again after an idle period
 - Functionality to be moved to userspace netd (NFLogListener)

Energy Aware Scheduler

- To make Linux scheduler fully aware of the CPU capabilities and optimize energy consumption
- Generic baseline design & Arch/SoC independent solution
- Under active development, testing and upstreaming phase
 - Patches/discussions can be tracked on lkml and ARM's linux-power.git repo
 - [LPC2017: Energy Aware scheduler development](#)





USB

- USB Gadgets

- USB device state changes
 - UEVENT notifications to userspace (UsbDeviceManager)
 - Custom device class interface (/sys/class/android_usb/android0)
 - Used mostly for legacy/non-configfs gadgets to track device state changes, functions enabled etc
 - Rejected upstream
 - Should read usb state changes from upstream interface /sys/class/udc/*/state instead
- Android Accessory driver
 - USB accessory mode allows users to connect USB host hardware specifically designed for Android-powered devices e.g. Kiosks
 - Audio Source driver
 - USB Audio support in accessory mode.
 - Android device serves as a data source to the host.
 - Accessory mode audio has not been widely adopted, and is not currently recommended for new designs.



USB

- Dual Role USB Phy sysfs interface
 - Generic `/sys/class/dual_role_usb/` interface to track and change the state of dual role usb ports
- OTG Wakelock
 - Grab a wakelock when vbus is present
 - Let user keep devices awake during charging
 - Or temporarily wake-up the device on charger connect/disconnect events

Android Verified Boot

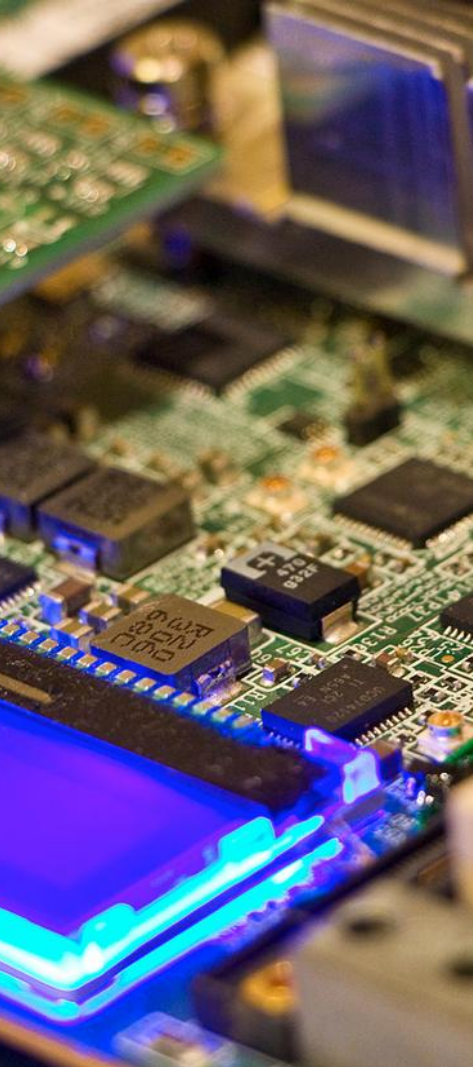
- Block-level integrity protection and forward error correction
 - For Android system and vendor/oem read-only partitions
- dm-android-verity
 - dm-verity extension to implement verified boot for Android
 - Helps ensure Android users booting a verified and trusted software
- dm-verity-fec
 - add sysfs attribute for stats



Input

- Keychord, keyreset/keycombo drivers
 - Drivers to handle different key press combinations
 - Chunks of it already upstreamed as part of SYSRQ driver
- Generic GPIO input support
 - Supports keyboard matrices
 - Direct inputs/outputs
 - Axes connected to gpios





FIQ debugger

- Low level kernel debugger for ARM
- Intended to use robust Fast IRQ (FIQ) interface for debugging
 - FIQ is similar to an NMI on x86
 - Debugger fall backs to using IRQ otherwise
- Parts of it already integrated with upstream KDB
- In Progress:
 - KDB extensions
 - fiq_debugger like feature for ARMv8
 - Extend NMI watchdog
 - IPI FIQ for ARM



Others

- Private Anonymous memory
 - Anon memory tagged/named by userspace to track and debug physical memory usage
- Scheduling Cgroups for cpusets, cpuctrl and schedtune
 - Restrict cpu-usage per task by putting apps into different buckets "TOP_APP / FOREGROUND / SYSTEM / BACKGROUND".
 - Let processes (system_server, binder viz.) move other tasks if they have CAP_SYS_NICE in the affected task's user namespace.
- Goldfish
 - Add goldfish sync driver
 - ACPI based enumeration of framebuffer and audio
 - Ranchu defconfigs



Others

- ARCH
 - Appended -dtb (Image.gz-dtb, Image-dtb) support
 - CONFIG_CMDLINE_EXTEND support
 - Dump memory around registers when displaying regs
- Tracing
 - MMC, GPU, Min/Max cpufreq, sched uninterruptible sleep tracing
- MMC
 - Sysfs interface for IO latency histogram
 - Additional retries on SD detection
 - Embedded sdio support and other sdio fixes
- Memory State Time driver
 - New memory_state_time driver tracks time spent in different DDR frequency and bandwidth states



Others

- Security / Perf
 - Add an option to restrict all access to performance events by users without CAP_SYS_ADMIN, to reduce the attack surface of the kernel
 - Shot down upstream <https://patchwork.kernel.org/patch/9249919/>
- Net
 - Sysfs based knobs for controlling TCP window size
 - Kconfig to keep RFKILL controlled devices awake during suspend
 - Sysctl knob to control the initial congestion window
- init
 - skip_initramfs option to allow choosing whether to boot using the initramfs or not at runtime.



Others

- FS
 - Tracepoints in ext4/f2fs/mpage to track readpages/buffered write()s.
 - Task I/O accounting: counter to track fsync
- NFC
 - Couple of buffer overflow and memory corruption fixes.
- Power
 - Log wakeup reason and source
 - Report suspend time
- UID SYS stats
 - Per UID based system statistics exported to /proc
 - For example: stats to be used by BatteryStats service

experimental/android-mainline-tracking

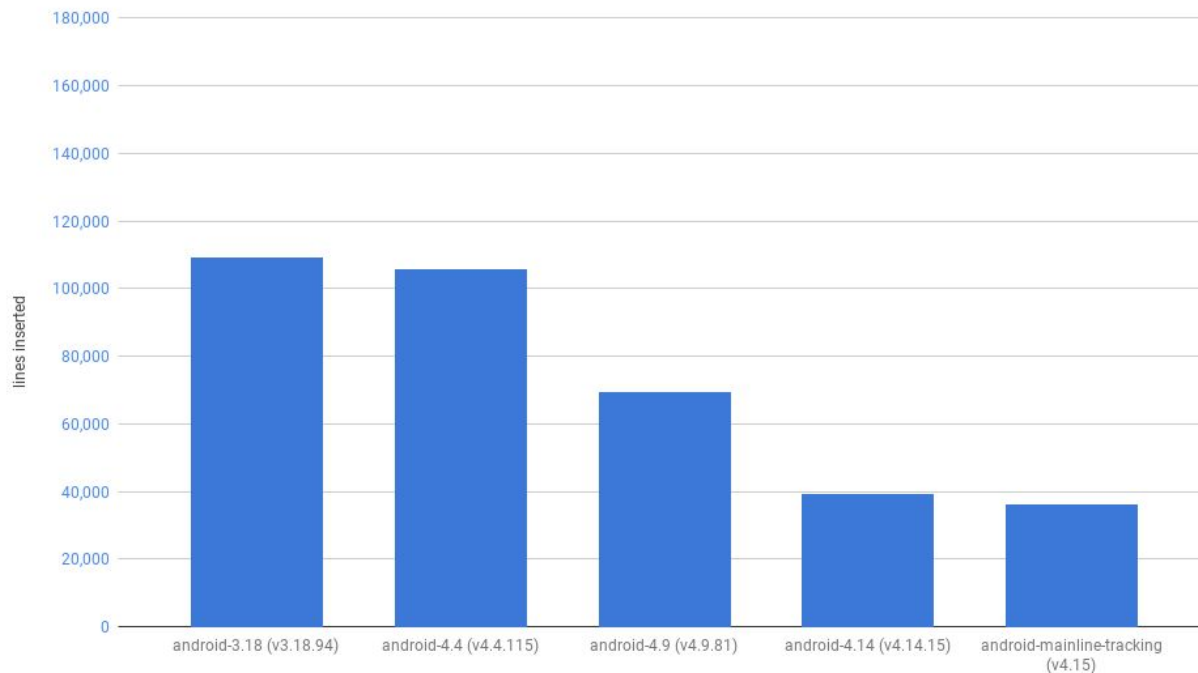
android-mainline-tracking Rationale

- Android patchset / features rebased to latest Linux release or -rc
 - Major non-LTS release versions are tagged. For example: experimental-android-4.15
- Find/Report/Fix Android regressions or ABI breakages in upstream kernel.
- Testbed for patches which are yet to be submitted upstream for RFC.
- To be used as a reference or experimental preview tree by member partners for upcoming SoCs.

v4.15..android-mainline-tracking git diff stats

- 369 files changed, 36272 insertions(+), 1741 deletions(-)
- ~13% Energy Aware Scheduling
- ~13% Sdcard FS
- ~13% Netfilter
- ~08% USB
- ~06% ARCH
- ~06% Input
- ~05% FIQ debugger
- ~04% Goldfish
- ~03% Device Mapper

Android Patchset Delta



Call To Action

- While a good chunk of Android changes have made it upstream, there is a good chunk of static delta that doesn't have an owner actively trying to upstream it.
- On an average around 38K lines of code keep getting rebased on next Android common kernels.



Thank You

For further information: www.linaro.org



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